



# Heliogyro-Configured Solar Sail Spacecraft

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# Solar Photons - Solar Sail Missions

## Heliophysics Missions

Solar sails are not only able to balance at  $L_1$ ,  $L_2$ , ...,  $L_5$  points but they are station-keeping at other regions in space without using fuel on board

De-orbit end of life satellites

$L_1$

Photons

$\theta$

Asteroid Mapping  
Asteroid Redirect  
Near Earth Object Monitoring

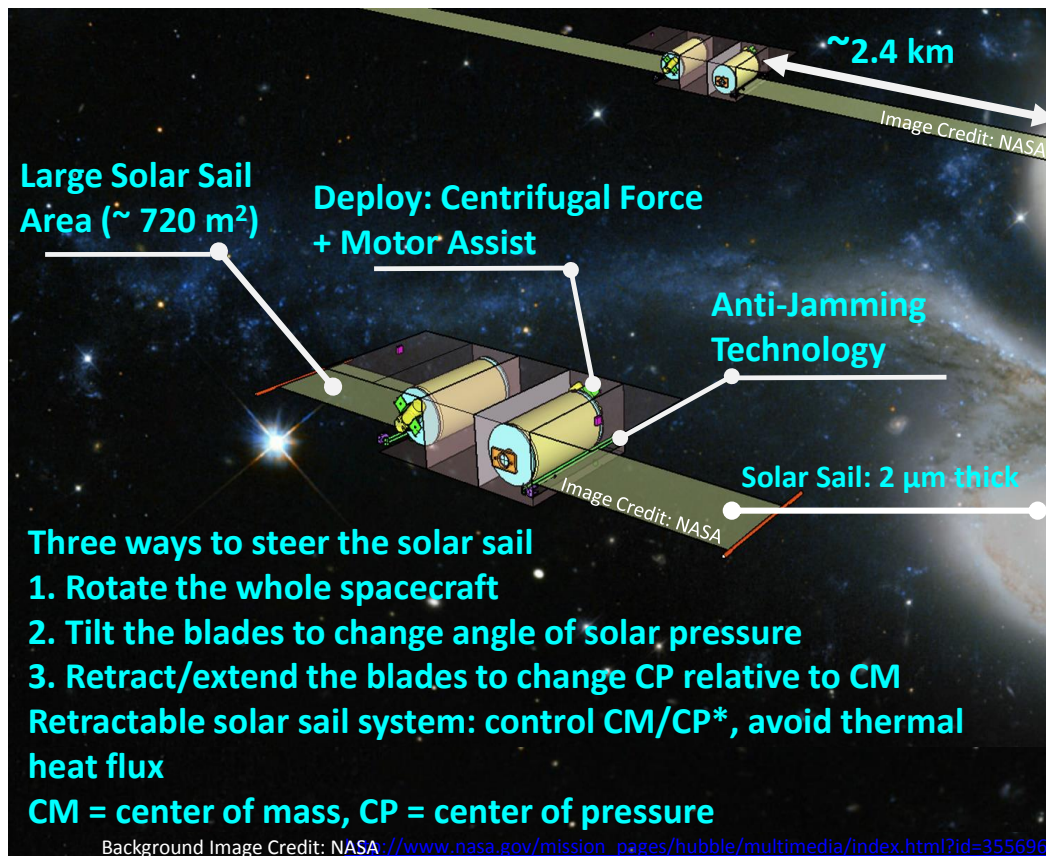
Image Credit:  
Bong Wie, Iowa State University

Background Image Credit: NASA [http://www.nasa.gov/centers/marshall/images/content/112448main\\_solar\\_sail\\_sun\\_earth\\_frame0016\\_4000x3000.jpg](http://www.nasa.gov/centers/marshall/images/content/112448main_solar_sail_sun_earth_frame0016_4000x3000.jpg)

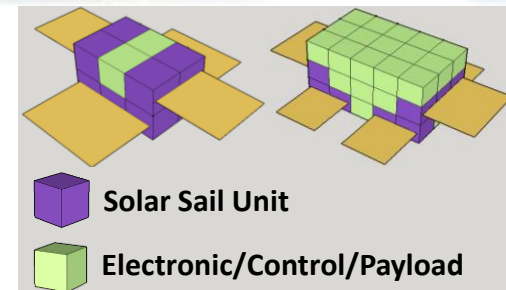
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## 2-Bladed Heliogyro Solar Sail



Background Image Credit: NASA: [www.nasa.gov/mission\\_pages/hubble/multimedia/index.html?id=355696](http://www.nasa.gov/mission_pages/hubble/multimedia/index.html?id=355696)



Heliogyro	Characteristic Acceleration [mm/s <sup>2</sup> ]	Sail Loading [g/m <sup>2</sup> ]	% of payload units to the whole spacecraft units
18U-4B(a)	0.85	9.68	33
18U-8B(a)	0.73	11.25	28
24U-4B(a)	0.75	10.94	41
24U-4B(b)	0.62	13.30	59
24U-4B(c)	0.64	12.90	50
30U-4B(a)	0.61	13.56	53
36U-4B(a)	0.58	14.13	56
42U-4B(a)	0.57	14.38	57
48U-4B(a)	0.56	14.58	58

28-41%

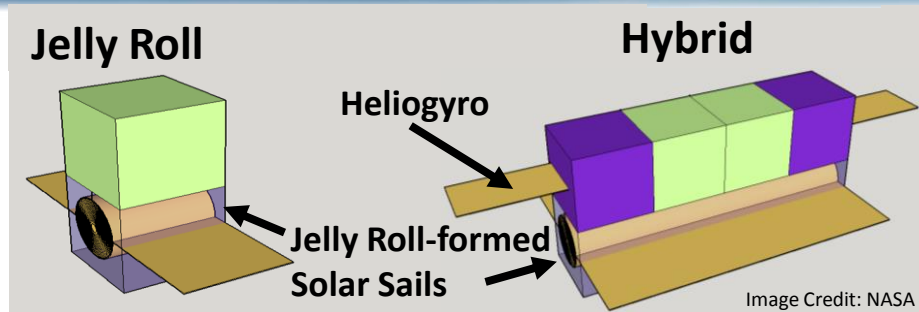
50-60%

> 55% of payload units → small accelerations

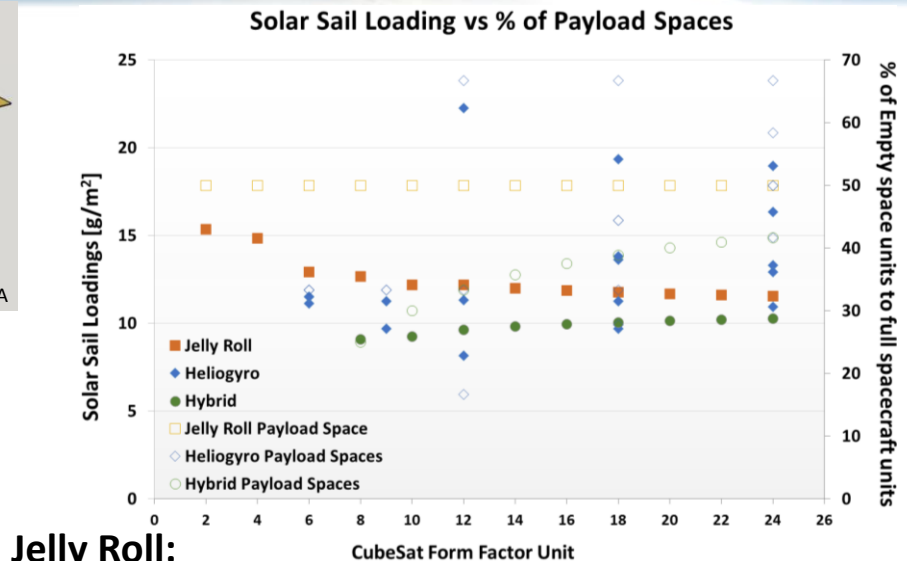
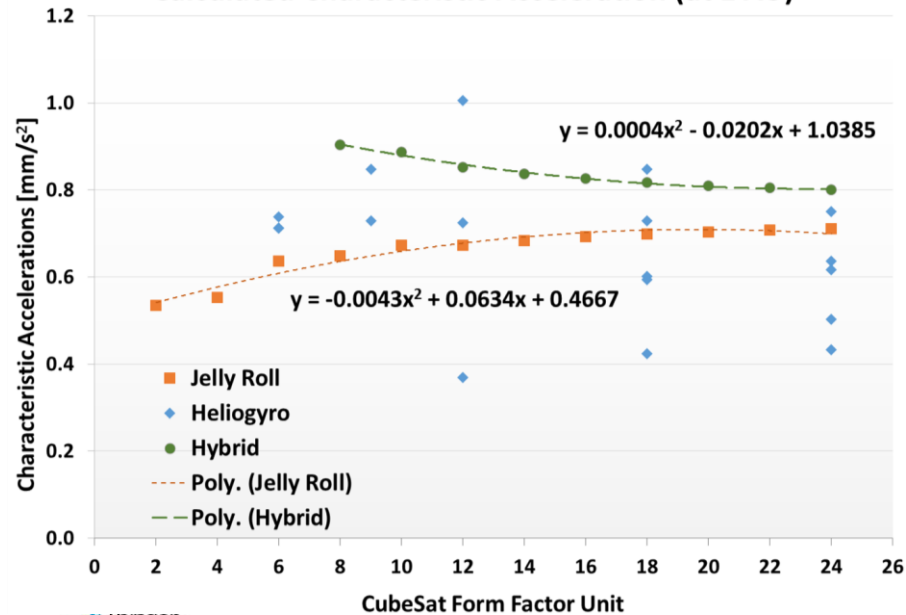
< 40% of payload units → large accelerations

Suggest: payload units < 40%, ~ **33% is the optimum**

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Calculated Characteristic Acceleration (at 1 AU)



## Jelly Roll:

≤12U → low to mid-range characteristic accelerations compare to Heliogyro configurations.

## Hybrid:

Accelerations stay in the high range of Jelly Roll and Heliogyro with insignificant decreases in accelerations as the size increases.

The hybrid's sail loading does not dramatically increase with size.

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# Summary

## Heliogyro:

Large accelerations ( $> \sim 0.7 \text{ mm/s}^2$ ), suggest  $< 40\%$  of payload units,  **$\sim 33\%$  is the optimum**

## Jelly Roll and Hybrid (Combination of Jelly Roll and Heliogyro)

Suggest: payload space  $\sim 30 - 40\%$  of the payload space to produce  $> 0.8 \text{ mm/s}^2$ .



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